CLAIMS

1. Method for determining the redox state of an anode of a high-temperature fuel cell, which is coated with or made from catalyst material, **characterized in that** at least a first resonator of a piezoelectric sensor device is brought into contact with the anode gas flow containing H_2 and/or CO and/or CH_4, of the high-temperature fuel cell, the surface of the first resonator being furnished with a coating which can be oxidized/reduced in the anode gas flow, and that at least one change in the resonance properties, preferably the resonance frequency, of the first resonator is measured and the redox state of the anode of the high-temperature fuel cell is inferred from this measurement.

2. Method for determining the redox state of a reaction surface of a reformer, which is coated with or made from catalyst material, **characterized in that** at least a first resonator of a piezoelectric sensor device is brought into contact with the gas flow containing H_2 and/or CO and/or CH_4, of the reformer, the surface of the first resonator being furnished with a coating which can be oxidized/ reduced in the gas flow, and that at least one change in the resonance properties, preferably the resonance frequency, of the first resonator is measured and the redox state of the reaction surface of the reformer is inferred from this measurement.

3. Method according to claim 1 or 2, **characterized in that**, depending on the measured change of resonance properties, preferably the change in resonance frequency, at least one

operational parameter of the high-temperature fuel cell or the reformer is controlled or adjusted.

4. Method according to any of claims 1 to 3, **characterized in that** at least one second resonator of the piezoelectric sensor device is brought into contact with the gas flow containing H_2 and/or CO and/or CH_4, said second resonator having a coating which is chemically stable, and that the frequency difference between the first and second resonator of the sensor device is used as a measure for the redox state of the oxidizable/reducible layer.

5. Method according to any of claims 1 to 4, **characterized in that** the resonance frequency of one of the two resonators, preferably the resonator with the chemically stable coating is measured and the measured value is used as a measure for the temperature in the gas flow.

6. Method according to any of claims 1 to 5, **characterized in that** the resonance resistance of one of the two resonators, preferably the resonator with the chemically stable coating, is measured and the measured value is used as a measure for the pressure in the gas flow.

7. Device for determining the redox state of an anode 11 of a high-temperature fuel cell 10, which is coated with or made from catalyst material, **characterized in that** at least one first resonator 3 of a piezoelectric sensor device 1 is positioned in the anode gas flow 5 of the high-temperature fuel cell 10, said first resonator 3 being provided with an oxidizable/reducible coating 4, and that there is provided a unit 8 for measuring at least one change of the resonance properties of said first resonator

3, the measured value being a measure for the redox state of the anode 11 of the high-temperature fuel cell 10.

8. Device for determining the redox state of a reaction surface 16 of a reformer 13, which is coated with or made from catalyst material, **characterized in that** at least one first resonator 3 of a piezoelectric sensor device 1 is positioned in the gas flow 5 of the reformer 13, said first resonator 3 being provided with an oxidizable/ reducible coating 4, and that there is provided a unit 8 for measuring at least one change of the resonance properties of said first resonator 3, the measured value being a measure for the redox state of the reaction surface 16 of the reformer 13.

9. Device according to claim 7 or 8, **characterized in that** the oxidizable/reducible coating 4 of the first resonator 3 is made from material identical with the catalyst material of the anode 11 of the high-temperature fuel cell 1 or the catalyst material of the reaction surface 16 of the reformer 13.

10. Device according to any of claims 7 to 9, **characterized in that** the oxidizable/reducible coating 4 of the first resonator 3 is made from nickel-cermet, Ni/NiO, Cu/CuO, Pb/PbO, Co/CoO, Ag/AgO, or Pd/PdO.

11. Device according to any of claims 7 to 10, **characterized in that** at least one second resonator 6 of the piezoelectric sensor device 1 is placed in the gas flow 5, said second resonator 6 having a coating 7 which is chemically stable in the gas flow 5.

12. Device according to claim 11, **characterized in that** the chemically stable coating 7 of the second resonator 6 is a noble metal or an oxide layer, such as SiO_2, TiO_2, Al_2O_3, CaO, MgO, or MnO.

13. Device according to claim 7, **characterized in that** the piezoelectric sensor device 1 is positioned on the outlet side of the anode gas flow 5.

14. Device according to claim 7, **characterized in that** the piezoelectric sensor device 1 is placed in the anode gas space 11' of the high-temperature fuel cell 10.

15. Device according to claim 8, **characterized in that** the piezoelectric sensor device 1 is placed on the inlet or outlet side of the gas flow into or from the reformer 13.

16. Piezoelectric sensor device 1 for determining the redox state of an oxidizable/reducible coating 4, **characterized in that** the oxidizable/reducible coating 4 is applied to the surface of at least one first resonator 3 of the sensor device, the resonator surface being flow-connected to the anode gas space 11' of a high-temperature fuel cell 10 or the gas space 13' of a reformer 13.

17. Piezoelectric sensor device 1 according to claim 16, **characterized in that** a chemically stable coating 7 is applied to the surface of at least one second resonator 6 of the sensor device, which coating does not show any redox behaviour in the gas flow 5 of the high-temperature fuel cell 10 or the reformer 13.

18. Piezoelectric sensor device 1 according to claim 16 or 17, **characterized in that** the chemically stable coating 7 and the oxidizable/reducible coating 4 are applied on two areas of a piezoelectric crystal element 2.

19. Piezoelectric sensor device 1 according to claim 17 or 18, **characterized in that** the chemically stable coating 7 is made from a noble metal or SiO_2, TiO_2, Al_2O_3, CaO, MgO, or MnO, whilst the oxidizable/reducible coating 4 is made from nickel-cermet, Ni/NiO, Cu/CuO, Pb/PbO, Co/CoO, Ag/AgO, or Pd/PdO.

20. Piezoelectric sensor device 1 according to any of claims 16 to 19, **characterized in that** the two resonators 3, 6 are configured as BAW- or SAW-resonators.

21. Piezoelectric sensor device 1 according to any of claims 16 to 20, **characterized in that** the first resonator 3 is configured as a BAW-resonator with oxidizable/reducible coatings 4 on opposite surfaces.